Remarks

The correction has been made on line 3 of claim 26, claim 14 has been canceled, claim 15 has been amended to depend on claim 1 and claim 22 has been amended. In view of these amendments and the following remarks, a reconsideration and allowance of this application is requested.

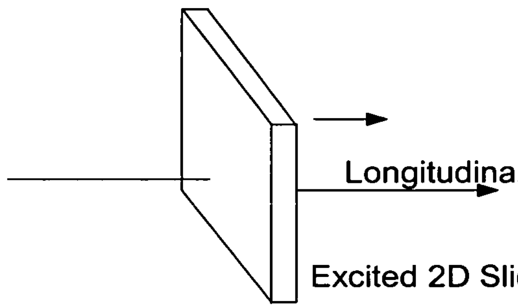
It is respectfully submitted that newly cited Margosian et al reference does not disclose or suggest the claimed invention. In a preliminary amendment previously made to claims 1, 7, 8, 9 and 18, changes were made to distinguish the claims over prior art that included the Pelc et al reference. These amendments also distinguish the claims over the newly sited Margosian et al reference.

Independent claims 1 and 18 were previously amended to indicate that each view is acquired with a pulse sequence having a readout gradient (i.e., the frequency encoding axis) directed along the same direction as table motion. Margosian et al disclose a method in which the readout gradient is perpendicular to the axis of table motion and which cannot be in the direction of table motion.

New claims 22-25 were added to more clearly recite the reconstruction of real-time monitor images during the movement of the patient through the scanner. While the monitor images depict only a small FOV as compared to the total FOV_{tot}, they do enable contrast agent to be seen as the scan is being performed so that table velocity can be adjusted to better track the peak in image enhancement provided by the contrast agent as it flows through the patient.

New claims 26-29 were added to more clearly recite the orientation of the slab of excited magnetization. As described starting at paragraph 19 and shown in Fig. 3, in the preferred embodiment of the invention an excited slab 12 has a thickness along the z-axis which is perpendicular to the axis of subject motion (the x-axis). The thickness of this slab 12 can be limited to include only the anatomy of interest and anatomy outside the slab 12 will not be aliased into the image. By limiting the thickness of the slab 12, fewer phase encoding steps are needed in the slab-select direction (z-axis) for a given image resolution. Fewer phase encoding steps results in faster scan time, and hence increased table velocity. Margosian et al cannot orient the excited slab in this manner.

The Margosian et al reference discloses a method for acquiring a series of 2D slice images as the patient table is moving "longitudinally" through the scanner (Col. 4, lines 29-32).



> "Preferably, the frequency of the RF excitation and refocusing is scaled in coordination with movement of the patient such that the position of the selected slice remains constant with respect to the moving patient for all views even as the selected slice shifts axially through the imaging volume." (Col. 5, lines 20-26)

> "A frequency scaling means 54 adjusts the RF amplifier 22 such that the RF excitation frequency and the RF demodulation frequency vary slightly with each view when the subject is moving through the imaging volume. The effect of this is to move the selected slice with the moving patient, so that it is fixed relative to the patient." (Col. 5, lines 30-37)

The readout axis in Margosian et al is in this 2D slice (along with a single phase encoding axis) and it is, therefore, perpendicular to the longitudinal axis of motion. A two-dimensional image is reconstructed from the acquired 2D data and each 2D slice image is stored (Col. 5, lines 56-66).

An important distinction between the present invention and the prior art is the method for adjusting each acquired view of MR data for table motion. In Margosian et al this is done prospectively by changing the RF excitation frequency such that the excited slice (2D) or slab (3D) moves with the patient. The consequence is that the slice or slab must be in a plane perpendicular to the axis of motion. Also, the view of MR data that is acquired does not need adjustment for table motion because the moving-slice method of acquisition takes care of the motion.

The teaching of the present invention is that the slice (2D) or slab (3D) should be oriented such that the readout axis in the plane of the slice/slab is directed along

the axis of motion. When this is done, each view can be Fourier transformed and stored in a data matrix. Table motion is accounted for by shifting the location in which this once-transformed data is stored. This is illustrated in Fig. 3 which shows the slab oriented such that the axis of table motion (x) is in the plane of the slab 12. The readout gradient in the pulse sequence of Fig. 2 is oriented along this same axis of motion(x).

The claims are believed to recite subject matter which patentably distinguishes over the prior art. Steps b) and c) in claim 1 are not disclosed or suggested by Margosian et al. Step b) calls for performing an imaging pulse sequence with its readout gradient directed along the direction of subject motion. As discussed above, the Margosian method requires that this gradient be perpendicular to the axis of motion. Step c) recites that each <u>acquired</u> view be adjusted for subject position. As discussed above, the Margosian method adjusts the RF excitation frequency such that each view is acquired as if the subject is stationary. As a result, there is no adjustment of each <u>acquired</u> view in Margosian et al to account for subject motion.

Claims 2-17 which depend on claim 1 are believed patentable for the same reasons. Applicants acknowledge the Examiner's allowance of dependent claims 7, 9, 10, 16 and 17. Others of the dependent claims are believed patentable for reasons beyond those described above for claim 1. For example, claim 11 calls for adjusting acquired views with table location information. Margosian et al have no such step. Claim 12 calls for Fourier transforming each acquired view and storing the transformed views in the data matrix at a location determined by table location. This is totally foreign to the Margosian et al method which acquires views and does a 2D Fourier transformation on the array of views to produce an image. The same is true of claim 13 which calls for phase adjusting an acquired view, doing a 1D Fourier transform on it and then storing it in the data matrix at a location determined by subject location. Claim 15 calls for Fourier transforming each view and storing it at a location in the data matrix determined by subject location. Margosian et al simply store each view in an array and then perform a 2D Fourier transformation on the array to produce a 2D image.

Independent claim 18 is patentable over the prior art for reasons similar to those discussed above for claim 1. Step b) calls for a pulse sequence which employs a readout gradient directed along the direction of table movement. Margosian et al cannot readout along the direction of table motion because their method requires that the slice/slab select gradient be directed along the longitudinal axis of motion, not the readout gradient. Step c) calls for adjusting each acquired view to account for the location of the moving subject. Margosian et al have no such step because their method acquires each view as if there was no subject motion (i.e., by moving the excited slice with the subject).

Dependent claims 19-21 are believed to recite patentable subject matter. In addition to the reasons discussed above for claim 18, claim 19 adds the concept of Fourier transforming each acquired view and storing it in the data matrix at a location determined by subject location. No such steps are disclosed, or are even possible with the Margosian et al method.

Claim 22 has been amended to clearly distinguish over the prior art. This claim recites the acquisition of views using a three-dimensional pulse sequence to acquire a 3D image that is larger than the FOV of the scanner. In addition, <u>as this 3D data is acquired</u>, two-dimensional monitor images are reconstructed. These real-time monitor images provide a means for observing how contrast is flowing into the FOV so that table velocity can be adjusted during the scan.

As discussed above, Margosian et al acquire MR data using 2D pulse sequence, and it is difficult to imagine how the technique disclosed in Margosian et al could be changed to employ a 3D pulse sequence. Independent claim 22 and dependent claims 23-25 are therefore believed to recite patentable subject matter.

Independent claim 26 recites subject matter which patentably distinguishes over the prior art in many ways. First, it employs a 3D pulse sequence in a continuous table motion setting which has not been done before the present invention. Second, the pulse sequence includes a slab select gradient which has an axis perpendicular to the axis in motion. Such a gradient would have to be <u>in</u> the direction of motion if Margosian et al were somehow to be changed to a 3D pulse sequence so that the excited slab would move with the subject. And finally, claim 26 calls for the readout gradient field to be <u>along</u> the axis of motion, whereas Margosian

et al cannot perform in this manner because it must have the slab select gradient in this direction.

Dependent claims 27-29 recite patentable subject matter. Dependent claim 27 adds the concept of Fourier transforming each acquired view, storing it in a data matrix and shifting its location along the direction of motion. Margosian et al have no such steps. Claim 28 calls for phase shifting each view to account for table motion and Margosian et al have no such step. Claim 29 is dependent on claim 28 and adds the shifting of the Fourier transformed and phase shifted view to account for subject movement.

A reconsideration of the pending claims is respectfully requested. While other continuous table motion MR acquisition methods have been proposed, it is believed that this method with the readout axis directed along the axis of motion is the best method to use for contrast enhanced MRA of the legs.

The Commissioner is authorized to charge any fees under 37 CRF § 1.17 that may be due on this application to Deposit Account 17-0055. The Commissioner is also authorized to treat this amendment and any future reply in this matter requiring a petition for an extension of time as incorporating a petition for extension of time for the appropriate length of time as provided by 37 CFR § 136(a)(3).

Respectfully submitted,

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